The resistance of aluminium laminated and aluminium lacquered thin band to the brines of different concentrations

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The meat industry products preserved by heat are packaged into packing made of metal, glass or complex band and foils. They are mostly packaged into tins.
Aluminium has a lot of positive physical characteristics. An important chemical characteristic is that is of very low redox-potential: the standard value being -1,66 V (Jovanović, 1968). Because of the low redox-potential, aluminium is very reactive, it's easily dissolving in acids developing gaseous hydrogen. When reacting with oxygen a layer of oxide is being formed on the surface and it prevents further oxidative changes (Jovanović, 1968; Lange, 1972; Hufnagel, 1978).
Due to its positive characteristics, aluminium is being used in food industry for the production of equipment as well as of packaging material.
According to Langen (1970), aluminium packaging material is being produced in the form of plate and bands (thickness over 0,35 mm), thin bands (thickness from 0,021 to 0,35 mm) and foil (thickness up to 0,021 mm).
Because of the high reactivity, the aluminium surface should be protected from interaction with the content.
The surface can be protected by lacquering i.d. by applying protective coating or by lamination of plastic foils.

THE OBJECTIVE OF THE PAPER

Containers made of thin aluminium band are used in the production of durable products, as well as for packaging a great number of food-products. However, this packaging material is not used in the production of perishable canned hams. For that reason the objective was to investigate the reaction of thin aluminium band on brines of different concentrations, as to establish the application possibility of this packaging material in the production of perishable canned hams.

MATERIALS AND METHODS

Containers made of thin aluminium band, laminated with polypropylene (Al.B.PP) or coated with thermolacquer (Al.B.TL), were used for the investigations. The net weight of the content was 400 g.
The containers investigated were filled with brines of three concentrations:
- brine I - NaCl 2,5%, $NaNO_2$ 0,03% and polyphosphate 0,5%
- brine II - NaCl 2,0%, $NaNO_2$ 0,02% and polyphosphate 0,3%
- brine III - NaCl 1,5%, $NaNO_2$ 0,01% and polyphosphate 0,1%

The pasteurization of the containers filled with brine was carried out under the following conditions: (A) in water, the temperature being 80°C, for 60 minutes without contrapressure and (B) in retort at the temperature of 100°C with the contrapressure of 50 kPa, also for 60 minutes.
The full and processed containers were stored at room temperature.
The containers were examined as to establish the signs of interaction: (a) just after the filling and closing, (b) after the pasteurization, as well as (c) 1, (d) 2 and (e) 3 months after pasteurization.
The examination of the packaging material for the changes, as a consequence of interaction with the brine, was carried out:

by visual inspection of the inside surfaces and
by the porosity determination of PP foil as well as of thermolacquer by the standard method with acidic solution of cuprisulphate, modified by Prinčić et al. (1979).

RESULTS

Al.B.PP containers

Visual inspection and porosity determination of Al.B.PP containers filled with brine were carried out but in neither of the examinations (a, b, c, d, e) were established any sorts of changes.

Al.B.TL containers

Considerable changes were established by visual inspection of the inside surfaces of Al.B.TL containers filled with brines of different concentrations. The results of this inspection are shown in table 1.

The results of porosity establishing of the surfaces of the same containers with brine are shown in table 2.

On the basis of the results shown in table 1 and 2, it can be seen that the changes on the lacquer appeared as early as after 1 month of storing and that they were intensified if further stored. As a consequence of such changes, after 3 months of storage, the perforation of all the samples investigated was established.

On the basis of the results shown in table 1, it can be seen that no changes were established in any part of the containers filled with the three kinds of brine immediately after the closing (a) and after the pasteurization by both procedure (b). However, after 1 month of storing (c) lacquer changes were established on the bottom and on the cover of containers pasteurized at 80°C/60 min, and on the bottom of containers which were pasteurized at 100°C/60 min. On these places, the lacquer came off the aluminium and became greyish.

The results of the visual examination of the inside surfaces of Al.B.TL containers filled with brines of different concentrations (n = 5)

Table 1.

Brine I,II,III	Heat treatment (°C/min)	Time of examination	Number of containers with changes on the bottom	cover	next to the seam
I		(a)	0	0	0
II					
III					
I	(A)	(b)	0	0	0
II	(A)	(b)	0	0	0
III	(A)	(b)	0	0	0
I	(B)	(b)	0	0	0
II	(B)	(b)	0	0	0
III	(B)	(b)	0	0	0
I	(A)	(c)	0	1	0
II	(A)	(c)	1	0	0
III	(A)	(c)	0	0	0
I	(B)	(c)	1	0	0
II	(B)	(c)	1	0	0
III	(B)	(c)	1	0	0
I	(A)	(d)	3	0	0
II	(A)	(d)	3	0	0
III	(A)	(d)	3	0	0
I	(B)	(d)	0	0	0
II	(B)	(d)	0	0	0
III	(B)	(d)	0	0	0
I	(A)	(e)	1	0	5(5)+
II	(A)	(e)	5(1)+	0	5(5)+
III	(A)	(e)	5	0	5(5)+
I	(B)	(e)	5(2)+	0	5(5)+
II	(B)	(e)	5(1)+	0	5(5)+
III	(B)	(e)	5(1)+	0	5(5)+

( ) number of perforated containers

The results of the porosity establishing of the surface of the Al.B.TL containers filled with brines of different concentrations (n = 5)

Table 2

Brine	Heat treatment (°C/min)	Time of examination	Number of containers with changes on the		
			bottom	cover	next to the seam
I,II,III		(a)	0	0	0
I	(A)	(b)	0	0	5
II	(A)	(b)	0	0	5
III	(A)	(b)	0	0	5
I	(B)	(b)	0	0	5
II	(B)	(b)	0	0	5
III	(B)	(b)	0	0	5
I	(A)	(c)	0	1	5
II	(A)	(c)	1	0	5
III	(A)	(c)	0	0	5
I	(B)	(c)	1	0	5
II	(B)	(c)	1	0	5
III	(B)	(c)	1	0	5
I	(A)	(d)	3	0	5
II	(A)	(d)	3	0	5
III	(A)	(d)	3	0	5
I	(B)	(d)	0	0	5
II	(B)	(d)	0	0	4
III	(B)	(d)	0	1	5
I	(A)	(e)	1	0	5(5)+
II	(A)	(e)	5(1)+	0	5(5)+
III	(A)	(e)	5	0	5(5)+
I	(B)	(e)	5(2)+	0	5(5)+
II	(B)	(e)	2(1)+	0	5(5)+
III	(B)	(e)	1(1)+	0	

+ ( ) number of perforated containers

When the containers were inspected after two months of storage, the lacquer changes were established in 3 containers from each group, which were pasteurized et 80°C/60 min, while in the containers pasteurized et 100°C/60 min there were no changes et all. By examination of samples stored for 3 months, lacquer changes of the bottom of all containers were established, with the exception of the containers filled with brine I, and pasteurized at 80°C/60 min. These changes were established next to the seam of all containers. Beside the lacquer damage, perforations were established on the bottom of 5 and next to the seam of all containers. On the bottom of the containers the thin aluminium band perforated, while next to the seam the perforation was established between the lacquer in the seam and the aluminium of the cover.

The changes found by lacquer porosity establishing (table 2) were the same as the ones found by visual inspection. Besides, porosity was established on the cover of 1 container pasteurized at 100°C/60 min, and stored for 2 months (d). The lacquer porosity next to the seam was established in all containers after pasteurization (b) and during storing (c, d, e) with the exception of 1 container which was pasteurized at 100°C/60 min and stored for 2 months (d).

DISCUSSION

No changes of Al.B.PP containers filled with brines of different concentrations were established by visual inspection and porosity establishing. It can be concluded on the basis of these results that the PP foil protecting layer doesn't react with the brine, and, therefore, it is not changing. That means that this material protects completely the thin aluminium band from the contact with the brine.

It was established by visual inspection of Al.B.TL containers filled with brines of different composition that the lacquer came off the aluminium and, on that place, it's colour was changed. On the basis of this change, it is reasonable to suppose that the structure

t lacquer has changed as well, and in that case,it's characteristics, including continu-
y, are changing. Because of the lacquer continuity interruption, the brine contacts and
acts with the aluminium.
the establishing of Al.B.TL containers' porosity, filled with brines of different con-
trations, the lacquer porosity next to the seam was established as early as after paste-
ization (table 2). Perforation of the container was established on the same places, na-
ly, next to the seam after 3 months of storage (but it was not the case with thin alumi-
um band). The porosity of lacquer layer of the bottom of the containers was established
fter 1 month storage (c), and after 3 months storage (e) porosity of thin aluminium band
the same part of a smaller number of containers was established. On the basis of these
sults it may be assumed that the aluminium begins to dissolve immediately after it con-
cts the brine. But the process of dissolving is gradually progressing and after 3 months
storing, it causes changes next to the seam and thin aluminium band perforation.
aluminium is dissolving in the brine, it is clear that it also gets into the content.
ough aluminium is considered suitable for food-products packaging, some authors, as re-
orted by Jovanović et al. (1979), consider it harmful for human health, especially in
nger amounts. Therefore, on the basis of the obtained results, it can be said that the
B.TL containers are not to be used as packaging material in the production of perishable
nned hams.

NCLUSION

the basis of the analysis of the investigation results it can be concluded:
that PP foil of the laminated thin aluminium band prevents the contact of aluminium and
ths, so this packaging material can be used in the production of perishable canned hams,
that the termolacquer coating becomes porous next to the seam as early as after pasteuri-
tion, and on the bottom of the container after 1 month of storing. The porosity was
creasing during the storing, so after 3 months the thermolacquer coating was porous in
l the samples examined,
that aluminium is dissolving in the brine and after 3 months of storing it was dissolved,
Al.B.TL containers became perforated. Therefore, this packaging material can't be used
the production of perishable canned hams.

ITERATURE

Hufnagel, W., 1978, Alu., 5, 342-345, 6, 403-406. 2. Jovanović, Lidija, M. Mugoša i
lica Djuričić, 1979, Tehn. voća i povrća, 13-14, 84-90. 3. Jovanović, M. S., 1968,
lektroanalitička hemija, Zavod za izdavanje udžbenika SRS, Beograd. 4. Lange, H.-J.,
972, Untersuchungsmethoden in der Konservenindustrie, Verlag Paul Parey, Berlin. 5. Lan-
en, H., 1970, Alu., 6, 6, 441-442. 6. Prinčić, Ksenija, Metka Gvardijančić, Marta Kovač
T. Kralj, 1979, Tehn. voća i povrća, 13-14, 103-106.